Chapter 1

Introduction

1.1. The master-apprentice relation in the knowledge economy

At the 2000 conference in Lisbon, the European Union formulated its ambition to become 'the most competitive and dynamic knowledge economy in the world'. The union members agreed to focus on state finances, economic growth, knowledge economy and innovation, full employability, and preservation of the natural environment. The Lisbon objectives turned out to be easier to formulate than to realise, almost eight years later most European countries still fail to meet the criteria of Lisbon 2000 (source: innovation platform, the Netherlands). Although the objectives have not been reached, the outcome of the conference in Lisbon does indicate where, according to the union, Europe's strength can be found: it is not in bulk production, cheap labour or agriculture, but in the knowledge economy. However, to become the most competitive and dynamic knowledge economy in the world, action is needed. In order to work and operate in a knowledge economy, adjustments have to be made within organisations. A second aspect is the acknowledgment of the source of strength in the knowledge economy and innovation: knowledge economy employees, that is, the knowledge workers. It is now agreed that today's economy is a knowledge economy, however for individual organisations it is not clear how they should manage their knowledge and the individual knowledge workers within this knowledge economy.

1.1.1. Knowledge sharing in the knowledge economy

To determine the right steps for organisations to take in managing their knowledge in a knowledge economy, it is helpful to look first at the history of the economy: how did Europe become a knowledge economy? The transition to this knowledge economy is, according to Jacobs (1999), a result of changes in organisations and changes in economic systems. Within organisations the interest in knowledge and knowledge management has increased. Knowledge has long been used and applied within organisations, but the use and applications are subject to change. In organisations the shift from physical labour to knowledge work, the changes in human resource management and the increasing mechanisation and automation have all led to a greater interest in, and need for, knowledge and knowledge management (Boersma, 2002). The rise of information and communication technology has further strengthened the position of knowledge within organisations

(Blaauw, 2005). According to Drucker (1993), knowledge is not just one of the resources within an organisation, but is in fact the only asset that matters.

It is clear that in the current economy the concept of knowledge plays an important – if not the most important – role. To realise the objectives of Lisbon, it is necessary to manage this knowledge. Knowledge – the insights, understandings, and practical know-how that we all possess – is the fundamental resource that allows us to function intelligently (Wiig, 1996). Therefore, managing knowledge is about managing the human beings who possess this knowledge. It is generally agreed that *knowledge sharing* is an important process within organisations (see for example Nonaka & Takeuchi, 1995; Davenport & Prusak, 1998; or Weggeman, 1997). Organisations usually try to achieve a collective outcome. They are created or emerge because none of the employees involved can produce the collective outcome alone (Boer, 2005). Furthermore, for new employees to be able to contribute to the collective outcome, existing knowledge has to be shared with them. Therefore organisations need to stimulate internal knowledge sharing. In order to understand the process of knowledge sharing, the concept of knowledge needs to be examined. A much-accepted characteristic of knowledge comes from Polanyi (1966), who divided knowledge in an explicit and a tacit form. Explicit knowledge can be explicated as opposed to tacit knowledge, which can hardly be made explicit. In this characterisation, explicit knowledge can be described as 'knowledge made out of ideas' and tacit knowledge as 'knowledge made out of skills' (see chapter 2 for a more detailed description of knowledge and its different forms). Tacit knowledge is not easily – if at all – made explicit and consists of the skills, experiences and intuition of people. The two types of knowledge are complementary. The difficulty of working with tacit knowledge arises from its own major characteristic: that it resides in the (unconscious) mind of the employees and is not easily explained to another person or written down on a piece of paper. Tacit knowledge *is known but cannot be told*, it is highly personal, internalised and deeply rooted in action and attitudes (Polanyi, 1966; Nonaka, 1995; Weggeman, 2001). Working with tacit knowledge assumes the sharing of it, for tacit knowledge that only exists within the individual employee is of no use to the company (Nonaka & Takeuchi, 1995). The tacit part of knowledge implies that knowledge sharing is not always an easy task to manage. If a person is not consciously aware of his knowledge or has emotional barriers, then electronic and IT-instruments cannot create knowledge sharing (Book & Gruhn, 2003). Knowledge sharing therefore, is not merely a technical task: it involves social aspects and psychological factors as well. In conclusion, sharing knowledge is an important aspect of organisations in the knowledge economy. The characteristics of knowledge imply that sharing both explicit and tacit knowledge can only really take place when the knowledge sharing participants are close together and can interact with each other.

The knowledge economy demands employees who can create and apply knowledge as well as using it in the process of innovation. The competitive ability of a company is largely

determined by the productivity and innovativeness of its personnel, and in particular the knowledge worker. Like the word itself suggests, knowledge workers are employees whose job consists of using and working with knowledge. They use little physical strength or special craftsman skills; instead they produce ideas, concepts, models and other information (Weggeman, 2001). A consequence of the observation that knowledge workers work with knowledge is that, for a knowledge worker to perform well, he has to keep learning. Davenport (1996) notes the characteristics of the processes that are linked with the work and activities of the knowledge worker in an organisation. There is variety and uncertainty regarding the inputs and outputs. There is an unclear division between input, throughput and output, partly as a consequence of the organic way of working – it is cyclic, interactive and the level of aggregation is variable. Other characteristics include the unstructured and individualised work regulations and routines, the autonomy for the knowledge worker, and the lack of rating possibilities or agreement on how individual performances are rated. A last characteristic is high variability in performances, both between knowledge workers and in time. Weggeman (2001) adds that knowledge workers' abilities are more exclusive than the labour that is added by other workers. This enables knowledge workers to make higher demands on the organisation they want to commit themselves to, in terms of both material and immaterial demands. A worker who fits the characteristics mentioned above, is however not always the person who will add the most specific value to the organisation. Additional conditions have to be met (Nonaka & Takeuchi, 1995). First of all, the knowledge worker has to have a high intellectual standard and a tendency to be committed to a reorganisation of the world by its own insights. The worker has to have a broad spectrum of experiences, originating from both within and without the organisation. He has to have the skills to start a dialogue with customers as well as co-workers. And lastly, the value-adding knowledge worker has to be open to discussion and debate with other knowledge workers. It is this type of knowledge worker who possesses the crucial knowledge of an organisation and determines the competitive strength of the company. These knowledge workers are the *experts* of the organisation. Experts have a large body of knowledge in a specific field. Expert knowledge is only present in these individuals – it is tacit knowledge – and is based on years of (deliberate) practice and experience (Ericsson & Lehmann, 1996). An expert is often one of the few people within an organisation who possesses the crucial tacit knowledge of that organisation. A consequence of this statement is that it is this group of employees who, to a large extent, determine the added economic value of the organisation. These experts may determine an organisation's strength, but they also make it vulnerable: individuals develop practical, often organisation-specific, expertise over the course of many years, but can walk out the door in a minute, taking with them all their expert organisational knowledge. When the knowledge of these experts is shared within the organisation, it has several positive effects: the expert's knowledge is preserved, it becomes available to more people, and non-experts can learn from it – helping novices to develop their own expertise.

More than the importance of knowledge sharing in general, the importance of sharing expert knowledge in particular will be discussed in this thesis. The characteristics of tacit knowledge and expert knowledge result in specific demands on the methods used to stimulate or facilitate this type of knowledge sharing. In literature, several techniques and methods are described that stimulate the sharing of (tacit) knowledge. For example introducing communities of practice (Wenger, 1999) or using storytelling and metaphors to share tacit knowledge (Martin, 1982; Nonaka & Takeuchi, 1995). A specific method is the master-apprentice relation. Several authors have suggested that the master-apprentice relation can be an effective method for sharing the tacit knowledge of experts. For example, Nonaka & Takeuchi (1995), Weggeman (2001) and Dreyfus & Dreyfus (2005) state that the master-apprentice relation is useful in improving knowledge sharing in organisations. This method focuses specifically on tacit knowledge sharing and expert development. The concept of the master-apprentice relation will be explored further in the next paragraph.

1.1.2. The master-apprentice relation

All experts once were novices. Throughout history experts have trained novices and seniors have taught juniors. When an experienced person trains an inexperienced person, this is called apprenticeship. Apprenticeship takes place within a master-apprentice relation. The master-apprentice relation is an old method which is characterized by the idea that when a novice is placed in the vicinity of an expert, the novice can watch the master at work and be trained in practice. The master-apprentice relation was a much used method to transfer expert knowledge in guilds during the middle ages (Epstein, 1991). In these guilds, apprentices were expected to internalize a process of work by watching a master artisan and then, in exactly the same way as their master had done, repeatedly produce the same simple or partial piece of work themselves. When the master judged the simple pieces as satisfactory, the apprentice advanced to more difficult and complete levels. The master-apprentice relation can be found in various societies throughout history and is still practised today in numerous settings. For example, in training medical students, the master-apprentice relation is used for the training of specific skills, as is the case in Germany's vocational training. The concept and language of the master-apprentice relation can also be found in totally different parts of society: for example, the terms 'master' and 'apprentice' also exists in Freemasonry, where members have to go through several degrees to become a 'Master Mason'.

The master-apprentice relation is about expert-based, on-the-job training (Wolek, 1999). Lave and Wenger (1991) explored apprenticeship and understood it to be a synonym for *situated learning*. These authors introduced the term *'legitimate peripheral learning*' as being the central defining characteristic in the process of learning viewed as a situated activity. Learners inevitably participate in communities of practitioners and the mastery of knowledge requires newcomers to move towards full participation in the sociocultural practices of a community (Lave & Wenger, 1991). Considering the present knowledge of

knowledge and knowledge management it is hard to imagine that a master-apprentice relation is only a matter of one-way learning: the master as well as the apprentice has to gain new knowledge as a result of participating in a master-apprentice relation (Von Krogh, 2002). In contemporary work environments, masters are likely to be co-learners (Kram, 1996), after all, 'it is impossible not to learn' (Weggeman, 2001). When an apprentice asks his master why he is precisely performing these actions and not others, the master is forced to work with his tacit knowledge and share it with his apprentice. This tacit knowledge sharing can exist in the apprentice copying the behaviour of his master, without him knowing exactly how and why. Another form is through explicating the tacit knowledge of the master (the master attempts to express his skills in words or metaphors). In master-apprentice relations new knowledge is created by the apprentice, by the master – or by both. When the master's knowledge has been made explicit, an additional gain is that this knowledge will also become available to the whole organisation. Another advantage is the situation in which the apprentice (consciously or unconsciously) catches the master being rigid: sometimes in such a matter the expert is so convinced of his own knowledge and skills, that he will disregard all alternatives. In other cases the expert may no longer be aware that there are other options besides his own methods to solve a problem. The apprentice looks at these situations with a fresh pair of eyes and can make the expert aware of his blind spots, thereby making it possible for the master and the apprentice to work together on renewal and improvements.

1.1.3. Problem statement

Although several authors name the master-apprentice relation as a useful method for sharing (tacit) knowledge in knowledge management (Nonaka & Takeuchi, 1995; Weggeman, 2001; Leonard & Swap 2005), little is known about how to establish a functioning master-apprentice relation in organisations and how to operate it. Factors like observation and imitation by the apprentice are known, but how and when those factors should appear in the relation is unclear. As was described in the introduction, the importance of knowledge sharing in organisations in the field of knowledge management is agreed upon. Furthermore, the relevance of tacit knowledge in organisations and the existence of crucial tacit knowledge belonging to experts within organisations is acknowledged. The sharing of this knowledge can serve several purposes: the preservation of existing knowledge within the company or, for example, the development of new expertise. The master-apprentice relation has been appointed as a suitable concept for sharing this knowledge. However, how can practitioners in the field make use of this concept? And can this old concept be used in contemporary organisations functioning in a knowledge economy? Just as the tacit knowledge residing in only one individual is of little use to the organisation, the master-apprentice relation is of little practical use if it remains just a concept. For the master-apprentice relation to become a useful method in the toolbox of knowledge management, the concept needs to be analysed and developed beyond its conceptual nature. Therefore, the question that this research seeks to answer is:

How can contemporary organisations establish and operate master-apprentice relations within their organisations in order to improve knowledge sharing?

This research attempts to find a solution to this problem. In the next paragraph the research framework is presented, starting with the research strategy.

1.2. Research framework

This paragraph presents the research framework. The first section discusses the research strategy which starts with the research objective. In the research strategy the research is formulated as a form of Design Science Research (DSR). The second section of this paragraph examines this specific research approach, after which the research design is discussed. In the last part of this paragraph the thesis outline is presented.

1.2.1. Research strategy

In the previous paragraph the research question was formulated as 'how can contemporary organisations establish and operate master-apprentice relations within their organisations in order to improve knowledge sharing'? When this problem is analysed, it becomes obvious that it is a practical issue: the need is observed by practitioners in the field. As a consequence of this, the solution should also have a relevant practical nature. For organisations to be able to actually make use of the concept of the master-apprentice relation, the created solution should be applicable and concrete. In the interest of science, it is relevant to take the concept of master-apprentice relations one step further by operationalising it and thereby exploring the underlying mechanisms.

To illustrate the creation of a new type of master-apprentice relation, and because the term 'master' assumes a type of hierarchic relation which may be considered old-fashioned, this research introduces the term '*expert-apprentice relation*' for the knowledge sharing that takes place between an expert and his apprentice. This research does not attempt to answer questions about the development of expertise, nor does it try to solve the ongoing debate on the definition of knowledge and knowledge sharing. By exploring the mechanisms behind expert-apprentice relations, this research tries to create a solution for practitioners who can use expert-apprentice relations to solve knowledge problems within their organisation. Therefore the research objective is described as follows:

to create a protocol for establishing and operating
expert-apprentice relations in contemporary organisations

The research objective can be qualified as a design objective: the objective is to create a solution for a specific field problem. Because the research objective is concerned with

answering a design question, a research strategy should be selected that matches the nature of the design objective. Design Science Research (DSR) is aimed at the creation of prescriptive knowledge for the improvement of professional practice. According to Andriessen (2007, p.90) "[i]*n* [DSR] *the researcher designs and tests interventions, congruently developing knowledge about the application domain of these interventions as well as insights about the underlying generative mechanisms for change. In designing the interventions, the researcher can make use of the results from theory-based research. Testing of the intervention will lead to practical solutions as well as a deeper insight into the validity and viability of the theory guiding the development of the intervention.*" This kind of research matches the specific characteristics of the research objective and therefore following DSR is appropriate for this research.

All research is based on assumptions. The way a researcher handles research can be characterised by his assumptions about how 'reality' can be known. This 'world-view' is also known as the researcher's 'paradigm'. According to Guba and Lincoln (1994), a paradigm may be viewed as a set of basic beliefs (or metaphysics) that deals with ultimates or first principles. It represents a world-view that defines the nature of the 'world', the individual's place in it, and the range of possible relationships to that world and its parts. Paradigms are based on ontological, epistemological, and methodological assumptions. The ontological assumption is about the form and nature of reality, while the epistemological assumption is about the nature of the relationship between the knower and what can be known. The methodological assumption is about how the inquirer can go about finding out whatever he believes can be known (Guba & Lincoln, 1994). There are different paradigms, and different classifications of the assumptions. A fundamental difference is that between foundationalists (positivisms) and anti-foundationalists (interpretivism / social-constructivism). Foundationalists believe that there is an objective reality which exists independently of existing knowledge. This reality can be discovered through empirical observations. On the other hand the anti-foundationalists (interpretivism) believe that the world is socially constructed and that the world can only be understood by subjectively interpreting observations of reality (Marsh & Smith, 2001).

This research follows the DSR approach. There is some debate whether DSR can be positioned as a paradigm. Some authors see DSR as a research methodology or as a research paradigm (Van Aken, 2004). However, Andriessen (2007) states that DSR is 'neither a paradigm nor a methodology' because although researchers in DSR share an epistemology, researchers may differ in their ontological point of view. Besides ontological differences, DSR researchers lack a common methodology. This research follows Andriessen (2007) in positioning DSR as a research approach aimed at answering a particular type of research problem, that is, the design problem.

In DSR, *pragmatism* is the shared underlying epistemological notion (Romme, 2003). Pragmatists consider practical consequences or real effects to be vital components of both meaning and truth. DSR develops knowledge in the service of action (Romme, 2003). DSR researchers however, may differ in their ontological viewpoint (Andriessen, 2007). Possible ontological viewpoints are critical realism, historical realism, and relativism. Realists detect social structures by designing descriptive and prescriptive models. Realists believe social structures have causal forces, therefore causal relations can be made. Realists state that not all direct phenomena are observable: deep, underlying structures cannot be observed. There is therefore a dichotomy between reality and appearance (Marsh & Smith, 2001). Researchers who adopt a relativistic ontology believe that there are multiple realities instead of an absolute one. This means that each person has his own reality. Besides epistemological assumptions and ontological assumptions, a paradigm encompasses methodological assumptions. Considering the methodology of DSR, researchers can draw from different research methodologies to test the validity of the design (Andriessen, 2007). A methodology is the route the researcher has to take in order to achieve a certain result: it is a system of methods and principles for doing something (Jonker & Pennink, 2004). In general, Yin (2003) suggests that within social sciences several different research methods can be distinguished: experiments, surveys, histories, analysis of archival information, and case studies. In section 1.2.3. the method of this research is explained, but first, to understand the characteristics of this research, DSR is discussed further.

1.2.2. Design Science Research (DSR)

As was stated in the previous paragraph, the main objective of this research is *to create a protocol for establishing and operating expert-apprentice relations in contemporary organisations*. This research is conducted using DSR. Design research is an emerging research approach, with its roots in engineering and the sciences of the artificial (Järvinnen, 2007). Even if it is common to think of engineers, architects, and industrial designers as typical professional designers, Simon (1988) stresses that everyone designs who devises courses of action aimed at changing existing situations into preferred ones. According to Hevner et al. (2004) the goal of design science research is utility. In this section DSR is further explained, starting with the gap between research and practice, or the *rigour-relevance dilemma*: *'Management theory is either scientifically proven, but then too reductionistic and hence too broad or too trivial to be of much practical relevance, or relevant to practice, but then lacking sufficient rigorous justification'* (Van Aken, 2004, p. 221).

The key quality criterion for the development of knowledge as an objective of academic research is validity. According to Van Aken (2005), for research at professional schools like business schools, there is a second criterion, namely *relevance*. The knowledge that is produced in such a setting 'should be relevant for the world of management and business' (Van Aken, 2005). Van Aken refers here to what is called 'the fundamental weakness of

organisation and management theory' (Romme, 2003), that is the so-called *relevance gap* between theory and practice. Organisation and management theory tends to be 'not obvious or relevant to practitioners'. Romme (2003) argues that the study of organisation needs a design approach. With this statement, he builds on the ideas of Simon (1996). According to Romme (2003) DSR involves the idea of design inquiry into new systems that do not yet exist – either complete new systems or new states of existing systems. "*Design is based on pragmatism as the underlying epistemological notion. Moreover*[DSR] *draws on 'design causality' to produce knowledge that is both actionable and open to validation. An important characteristic of design is the use of ideal target systems when defining the initial situation"* (Romme, 2003). In the design sciences, academic research objectives are of a more pragmatic nature. Research can be seen as a quest for understanding and improving human performance. It is solution-oriented, using the results of description-oriented research from supporting (explanatory) disciplines as well as from its own efforts, but the ultimate objective of academic research in these disciplines is to produce knowledge that can be used in designing solutions to field problems (Van Aken, 2005). Stated as such, the design mode is a form of Mode 2 knowledge production (Van Aken, 2005). Within science there is a distinction between Mode 1 and Mode 2 knowledge production. Mode 1 production is purely academic and mono-disciplinary, while Mode 2 is multi-disciplinary and aims at solving complex and relevant field problems. Mode 2 knowledge production is presented as the example to follow in academic management research to bridge the relevance gap.

According to Van Aken (2007) the knowledge products of Mode 2 research (i.e. DSR) are the 'field-tested and grounded solution concepts', these concepts can be used in the designing of solutions to field problems. This is inspired by the design sciences like medicine and engineering: the mission of a design science is to develop knowledge that the professionals of the discipline in question can use to design solutions for their field problems. This in comparison to the mission of 'explanatory sciences' like natural science and sociology, which is to develop knowledge to describe, explain and predict. Van Aken (2005) calls the latter Organization Theory, and the former, knowledge resulting from research based on the approach of the design sciences, Management Theory. Van Aken (2005) advances the thesis that the relevance of the products of academic management research may be improved if they would also include prescriptive, solution-oriented (or: design-oriented) knowledge. As is stated above, the core mission of DSR is to develop knowledge that can be used by professionals in the field in questions of design solutions to their field problems. Understanding the nature and causes of problems can be a great help in designing solutions. However DSR does not limit itself to understanding, but also develops knowledge on the advantages and disadvantages of alternative solutions.

As is stated above, the typical research products in DSR are the 'field-tested and grounded solution concepts'. These design propositions or heuristic technological rules, can be

descriptive, but the typical solution concept is solution-focused, prescriptive, giving a type of solution for a certain class of field problems. Van Aken states that solution-focussed solution concepts can have a substantive nature as well as a procedural one. If a concept is 'field-tested', this means it is tested in its intended field of application. Field-testing is done for the sake of justification of the concept. If a solution concept is 'grounded' this means it is known why the intervention or artefact gives the desired performance. Grounding can be done with insights from the social sciences.

In general, Hevner et al. (2004), building on March and Smith (1995), presented a design science framework and guidelines around building and evaluating (IT) artifacts. Hevner et al. expressed their view on what constitutes good, rigorous and relevant, design science in the form of seven guidelines. The authors contend that each of the guidelines should be addressed in some manner for design science research to be complete. The guidelines are on the product of design science, the relevance of the problem, the criteria for evaluating the design solutions, the research contributions, the research rigor, the design as a search and the communication of the research. More specifically on the research product, Van Aken introduces CIMO-logic. In contrast to Mode 1 research, where the research products tend to focus on the discovery of general causal relationships among variables ('*If X and Y, then Z*', or: '*X is negatively related to* Y') (Romme, 2003), in DSR, the solution concepts follow *CIMO-logic*, meaning Context – Intervention – Mechanism – Outcome (Van Aken, 2007). CIMO-logic runs as follows: *"In this class of problematic Contexts you may use this Intervention type, which will produce through these generative Mechanism(s) these Outcome(s)."*. The remainder of the product is a kind of user instruction connecting the solution concept with the field problem, including indications and contraindications, i.e. knowledge on when to use or not to use the solution concept. Van Aken (2005) states that in management solution concepts should be given with 'thick descriptions' to aid their understanding and to facilitate their translation from the general to the specific concept. These thick descriptions should be based on the field testing and grounding of the propositions. The concept of 'thick descriptions' was used by Geertz (1973) and is about giving room to all possible explanations of a particular situation. A thick description has three elements: an interpretation, a social discourse, and trying to find a meaning which is applicable to the situation, free of the context.

Van Aken (2005) emphasizes that in the design of management action, solution concepts are not to be used as instructions, but rather as design exemplars. Practitioners have to choose solution concepts for their organisational problem and then they have to translate this general rule to their specific problem by designing a specific variant of it (Van Aken, 2005). Further, he states that the effective use needs considerable expertise: a thorough understanding of the design with its indications and contraindications. Also, a thorough understanding of the local situation, cognitive skills in translating the general to the specific, and social skills are required to 'mobilize the organisational actors to act according

to the design'. After this redesign from the general into the specific, a second redesign is needed: the design of their behaviour by the organisational actors themselves and also their collective construction of new organisational realities. This dual redesign implies that there is only a long-standing relationship between the formal design and ultimate performance (Van Aken, 2005). Or as Van Aken illustrates this: "O*ne might compare this contribution with the one of a well-designed route, drawn on a good map for a South Pole expedition. It is a valuable asset to realize eventual success (reaching the South Pole and returning home safely), but success is not guaranteed. The quality of the people involved, leadership and resources, perseverance and luck also play a part. Nevertheless, a good route on a good map is still highly valued by the members of the expedition."*

1.2.3. Research design

The research products of DSR research are solution concepts. The product of this research is a solution concept for addressing the problem of establishing and operating master-apprentice relations within contemporary organisations. In the research objective the term '*protocol*' is used. To understand the differences between a design and the objective of this research, a protocol, the analogy of a recipe can be used. For example, when creating a new cake, the *design* is the process of realising the recipe of the cake: it is not the recipe itself. The *result of the design* is the recipe for a new kind of cake. The *result of the application of the recipe* is the new cake. The design has to fulfil certain requirements. For example, the cake needs to be low-fat and therefore the design should meet the requirement that the recipe cannot contain too much butter. The recipe then, is the practical operating procedure by which the cake can be baked. In this research requirements will be collected for the design: the *result of the design* is a protocol for creating expert-apprentice relations. Application of the protocol will result in actual expert-apprentice relations in contemporary organisations. In order to create a design, the requirements the design has to comply with have to be known.

There are different types of requirements for the design. In this research, the requirements are categorized following the categorisation of Van Aken, Berends and Van der Bij (2006). This categorisation consists of four categories, namely (1) functional requirements, (2) user requirements, (3) boundary conditions, and (4) design restrictions, with every category representing a different functional specification for the design. The requirements are illustrated by using the analogy of the cake recipe:

- Functional requirements are the core of the specification and are in the form of performance demands on the object to be designed. For the design of the cake recipe, a functional requirement could be that the cake has to taste sweet;
- Specific requirements from the viewpoint of the user are called user requirements. For example in the design of the cake recipe, a user requirement is that it should be easy for the maker to handle the dough.

- Boundary conditions are requirements that have to be met unconditionally. For example in the case of the cake, a boundary condition is that the cake has to fit in a standard cake tin.
- Design restrictions are the fourth category and are about the preferred solution space. In the case of the cake, a design restriction is that the cake should preferably fit on a standard.

In this research a fifth category is added, namely *Attention points*. Attention points are those specifications which are relevant to the design and should be noted, but which are not hard requirements and cannot be named design restrictions. For example, an attention point in designing the cake recipe is that the cake is to be eaten at a birthday party.

In this research the requirements concentrate on the content of the expert-apprentice relation and from that viewpoint influence the construction of the protocol. Functional requirements are requirements for the design of the protocol that involve the qualities, characteristics and outcomes of the expert-apprentice relation. It is important to note that in this research the facilitator of the expert-apprentice relation is the *user* of the design. This means that the category 'user requirements' is set up from the viewpoint of the relation *facilitator*, and not from the viewpoint of the *participants*, i.e. the expert and apprentice. Required actions of the expert and apprentice are therefore placed in the category 'functional requirements', because they are part of the outcomes of the design. The requirements that concern enabling the expert-apprentice relation and composing the relation are placed in the category 'user requirements'. Boundary conditions are conditions that have to be met for the expert-apprentice relation to function. The design covers the selection and matching of the participants. Part of this is that the facilitator has the task to meet the boundary conditions. Design restrictions and attention points stand lower in the hierarchy than functional requirements, user requirements, and boundary conditions. They encompass preferred routes, or requirements that apply in some but not all cases. In this research all requirements are placed in one of the above-described categories. The categorisation of the requirements is often subjective. The assignment of the requirements to one of the five categories is done by *educated guess*, because in most cases no objective assignment is possible. This implicates that if several persons would categorise the requirements, this could result in different outcomes. Each person can make different choices, resulting in a different categorisation of the requirements. However, the motive for the categorisation is merely to create a system in the chaos. The categorisation is not an objective in itself: the only goal is to systemize the list of requirements. In the protocol, which is the result of this research, the categorisation is removed. Therefore, if a requirement is placed in a different category this will not influence the ultimate protocol.

Theory and practice are interdependent and therefore DSR's dual purpose of contributing simultaneously to theory and practice is expressed in two distinctive but interwoven streams of inquiry, namely the knowledge stream and the practice stream (Andriessen,

2007). The practice stream aims at solving specific problems in specific situations, whereas the knowledge stream focuses on producing generalisable and transferable knowledge that can be used as solution concepts for solving similar problems in similar contexts. Both streams are based on different learning cycles. The practice stream is based on the problem solving cycle, which consists of the following phases: defining the problem; planning the intervention; applying the intervention; and evaluating the intervention. The problem solving cycle concerns *reflection-in-action*. The knowledge stream is based on the *reflective cycle*. The reflective cycle is a combination of the problem solving cycle of the professional aiming to solve a unique and specific problem and the scientist aiming to develop general knowledge which can be used in a class of comparable problems (Andriessen, 2007):

1. Choosing a case;
2. Planning and implementing interventions (on the basis of the problem solving cycle);
3. Reflecting on the results;
4. Developing design knowledge;
5. Testing and refining of the design knowledge in subsequent cases.

Solution concepts are typically studied within their intended context of application, in order to be as sure as possible of their effectiveness, also under the influence of less well-known factors. According to Van Aken (2004), the typical research design to study and test solution concepts is the multiple case study. A series of same class problems is solved by applying the problem solving cycle to each one, while design knowledge is built up through the reflective cycle. Testing the solution concept in its intended context can lead to sufficient supporting evidence or theoretical saturation: DSR is justified by pragmatic validity (Van Aken, 2004). In developing and testing the solution concepts through multiple cases and in analysing its effectiveness through cross-case analysis during the reflective cycle, one can gain insight in the indications and contraindications of the application and hence in its application-domain. Because, according to Van Aken (2004), a solution concept is typically not totally general, but applicable to a certain application-domain: a class of problems.

In this research the requirements that apply to the design of the protocol for establishing and operating expert-apprentice relations in contemporary organisations have to be explored. In order to do so this research consists of different phases. First, an exploration of existing literature gives insight in the underlying generative mechanisms. The existing literature provides findings that are relevant to the design. After each theoretical section, the relevant findings will be presented. In this first stage, literature is studied that covers the different aspects and components of expert-apprentice relations: knowledge sharing and learning in a social relation that includes an expert and a novice. Therefore literature on knowledge and knowledge sharing, learning, and the development of expertise is studied in order to extract relevant findings for the research. Besides studying the different aspects of

expert-apprentice relations, the expert-apprentice relations as a concept used in other times (medieval guilds) and cultures (Japanese sempai-kohai relations) are studied.

Besides the studying of literature, this research uses case studies. Case studies are a specific type of research instrument. Other instruments include, among others, experiments, surveys and grounded theory. Case study research is intended to examine a phenomenon in its natural setting where the boundaries between the phenomenon and its context are not clearly evident and in which multiple sources of evidence are used (Yin, 2003). Case studies have disadvantages as well as advantages: for example a drawback is the lack of statistical evidence. However, by using multiple and often qualitative methods, the researcher can learn much more from processes than is possible with techniques such as surveys (Yin, 2003). In case studies multiple sources of data are used. In this research observation, documentation and interviews have been used in compiling data. The data collection is further described in chapter four where the results of the explorative case studies are presented. In this research in total thirty cases were studied. These cases can be divided into three classes: exploratory cases, developing cases, and test cases. In the exploratory cases six expert-apprentice relations were formed that were studied without process intervention. The pilot results in relevant findings for the design (see chapter four). In the second class of cases the method was developed in twenty expert-apprentice relations. These twenty cases were spread over a three-year period, with an overlap between the cases. Each case lasted about six months (see chapter seven for a case description). During this period the method was developed, implemented, evaluated, redesigned, further developed and implemented again in subsequent cases. The third class of cases is the test cases in which the final protocol was tested and evaluated (see chapter seven).

1.2.4. Thesis outline

The structure of this research is as follows: chapter 1 introduces the master-apprentice relation in the knowledge economy, followed by a description of the framework of this research. The second chapter studies literature on knowledge and knowledge sharing, experts and expertise, and learning in order to identify the underlying generative mechanisms of the expert-apprentice relation. Each section is followed by a summary of the relevant findings. Chapter 3 studies examples of expert-apprentice relations in other times and cultures. Two forms of expert-apprentice relations are further analysed. First, the medieval master-apprentice relation is examined, followed by the sempai-kohai relation which originates in Japan. Again, the chapter ends with an evaluation of the relevant findings. Chapter 4 gives the results of six exploratory cases studies, in which the expert-apprentice relation was performed. The relevant findings are evaluated and combined with the findings of the previous chapters in Chapter 5. Chapter 5 explains the conversion from relevant findings into design requirements for the protocol. The design requirements are categorised into functional requirements, user requirements, boundary conditions, design requirements and attention points. Chapter 6 presents a preliminary design of the protocol.

This design is further developed through twenty field-test case studies, which are described in this chapter. In the following chapter, chapter 7, the results of the design process are presented: the C4 protocol for expert-apprentice relations. Four case studies are used to test the protocol. These cases are discussed in chapter 8. Chapter 9 includes an evaluation of the findings, concludes the research and provides suggestions for further research.